

WHAT IS CLAIMED IS:

1. An ion implantation method for implanting hydrogen ions to a predetermined depth of a semiconductor substrate, comprising steps of:

5 introducing hydrogen gas into a chamber where an inner pressure is reduced and a predetermined magnetic field is formed;

generating plasma by introducing a microwave into the magnetic field;

10 extracting hydrogen ion beams containing hydrogen molecule ions from the plasma; and

irradiating the hydrogen molecule ions onto the semiconductor substrate.

15 2. The ion implantation method according to claim 1, wherein a frequency of the microwave and an intensity of the magnetic field satisfy conditions represented by any of following expressions:

$$\omega > \frac{eB}{2\pi m_e}$$

$$\omega < \frac{eB}{2\pi m_e}$$

20 where  $\omega$  is the frequency of the microwave,  $m_e$  is a mass of electrons,  $e$  is a charge of the electrons, and  $B$  is the intensity of the magnetic field.

3. The ion implantation method according to claim 1, wherein a mean residential time of hydrogen molecules from the

introduction of the hydrogen gas into a generation region of the plasma to the extraction of the hydrogen ion beams ranges from  $5 \times 10^{-4}$  to  $5 \times 10^{-3}$  seconds.

4. The ion implantation method according to claim 1, wherein one including an insulating layer on a Si substrate is used as the semiconductor substrate, and the hydrogen molecule ions are implanted to a predetermined depth of the Si substrate by irradiating the hydrogen molecule ions from a side of the insulating layer.

5. The ion implantation method according to claims 1, wherein one including a  $\text{SiO}_2$  layer on the Si substrate is used as the semiconductor substrate, and the hydrogen molecule ions are implanted to a predetermined depth of the Si substrate by irradiating the hydrogen molecule ions from a side of the  $\text{SiO}_2$  layer.

10 6. A method for manufacturing an SOI wafer, comprising:

an ion implantation step of forming a hydrogen ion implanted layer to a predetermined depth of a first wafer having an insulating layer on one surface of a Si substrate by the 15 ion implantation method according to claim 1;

a layering step of obtaining a layered body by layering a second wafer formed of a Si substrate on the insulating layer of the first wafer having been subjected to the ion implantation step; and

20 25 a partition step of partitioning the layered body at the hydrogen ion implanted layer.

7. The method for manufacturing an SOI wafer according to claim 6, wherein the insulating layer is a SiO<sub>2</sub> layer.

8. A method for manufacturing a SOI wafer, comprising:

5 an ion implantation step of forming a hydrogen ion implanted layer to a predetermined depth of a third wafer formed of a Si substrate by the ion implantation method according to claim 1;

10 a layering step of obtaining a layered body by layering an insulating layer and a second wafer formed of a Si substrate on a predetermined surface of the third wafer having been subjected to the ion implantation step; and

a partition step of partitioning the layered body at the hydrogen ion implanted layer.

9. The method for manufacturing an SOI wafer according to claim 8, wherein the insulating layer is a SiO<sub>2</sub> layer.